Programmed for productivity

Scitex built the Response family of pre-press systems as high-efficiency problem-solvers for quality color page preparation. The system enjoys a challenge in terms of racing through routine color corrections and page-assembly jobs, boosting each worker's productivity by joining him in instant interactive processing.

At each site, Scitex maximizes productivity and return on investment by installing the price/performance option with the highest promise for the work involved. As a systems technology company with a full range of models and options available, Scitex analyzes customer sites with an eye to placing not the maximum, but the optimum, in equipment.

As images move electronically from scanning to pagination to outout, the result is a new level of productivity. Some plants may measure it in terms of pages per day, others may figure how many man-hours the same quality would require by old methods. One benefit cannot be measured: within months of starting up, users report they receive jobs that "could not have been handled any other way." What is measurable, the speed-up in turnaround time and the upturn in productivity, is clear at every checkpoint, including the proverbial bottom line.

Faster than film

From the time color art is submitted until the final approvals and press-run, the Response system need never pause to expose film separations for correction or assembly. The operator can see separations on his video screen, and can even produce proofs whenever he wishes, but all the traditional manipulations of intermediate films — masking, staging, dot-etching, and so forth — are replaced by Scitex's software for electronic pre-press. The electronic image, captured at the outset from a color separation scanner, undergoes all the appropriate work while embodied in numbers turning over in the computer's mind.

This uninterrupted process consists of electronic steps equivalent to masking, dot-etching, airbrushing, and other processes, each step many times faster than the traditional work on negatives. The sequence of work is flexible, for example permitting last-minute color-correction work even after page assembly. The system can remedy errors which on films would mean waste and delays, simply by recalling the picture from memory in its previous form.

Scitex has bypassed the pitfalls and delays of traditional graphics, and the resulting acceleration of the pre-press process permits tighter deadlines without compromises in quality.

Letting it all add up

Some Response users have remarked that their savings in films and other consumables rapidly add up to offset the system's whole purchase price. But in addition to those savings, digital Response pre-press gives unprecedented flexibility and accuracy, allowing human skills to achieve higher quality.

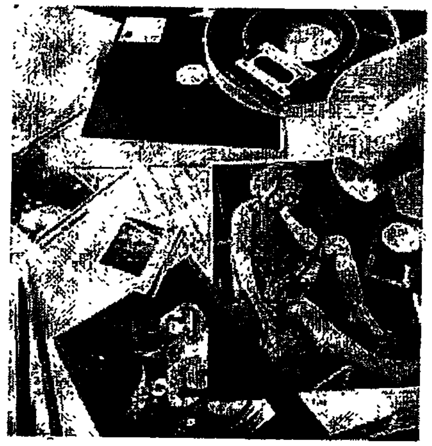
It is a fact that computers have no aesthetic sense. What a computer system can do is help the human eye reach the desired graphic effect in a fraction of the time that labyrinthine old methods take. The Response system's capabilities include levels of graphic exactitude that no amount of traditional effort could achieve, such as mathematically perfect dot-by-dot tint transitions for dégradé effects, and masks more intricate than otherwise feasible.

Every human touch is quantified in the computer's memory, so that the system provides the ultimate in accuracy and repeatability.

A job, or even a single separation, recalled from digital storage at any time will reproduce just as it did originally. Individual pictures, once scanned and approved, can be re-used or adapted in job after job without duplication of effort.

Electronic art, by Ikko Tanaka at the Response console, courtesy of Toyo Ink, Tokyo

What goes in and what comes out...

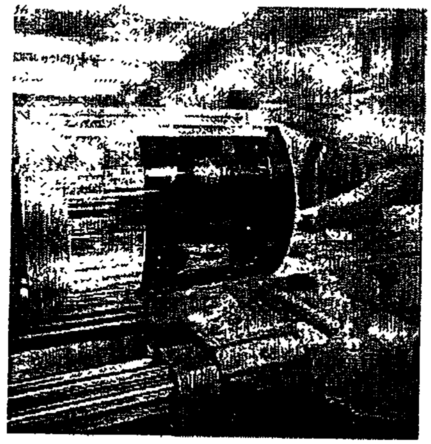


Scitex accompanies you electronically along the accustomed route to press, from the receipt of originals to the production of image carriers for lithography, offset, gravure, or letterpress. The Response system prepares pages similarly for all media, and any page can be output to any medium or to more than one.

As input, the system accepts color transparencies and opaque art of all kinds on any smooth, flexible medium. Mechanicals may be fed into the system for its electronic use, or used only by the operator supplying guidance. Masks can be included as input if already prepared, but they are simple to create electronically in the course of Response work. Composed text can be accepted from a galley or mechanical, or taken directly from a front-end composition system through Scitex's powerful built-in TEXTA Typesetter.

Proofs and finished pages are copied out from computer memory onto continuous-tone or halftone films, directly to laser-sensitive lithographic plates, or to a Scitex subsystem for filmless gravure engraving. In digital form, all images can be transmitted, duplicated, archived and retrieved like any other data. The growing archive of quickly accessible print-ready images makes each day's work a potential head start on future jobs.

...and what goes on inside



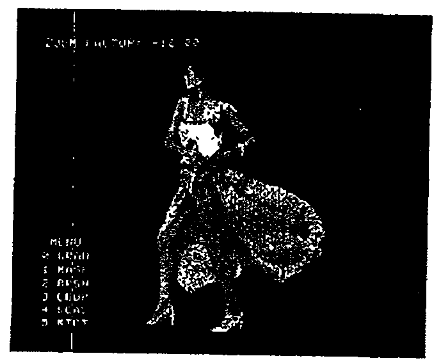
To govern the Response system's graphic equipment, Scitex system engineers have built a complete software emulation of the pre-press process, systematized as a continuous, flexible man/machine dialogue.

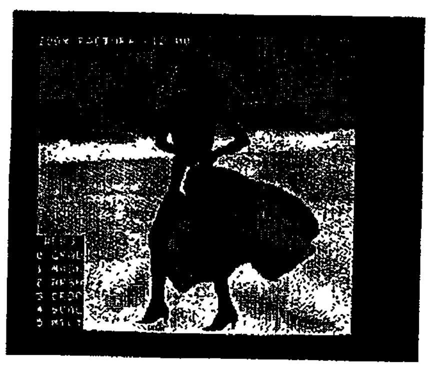
This synergy of software and hardware can merge and process images read in from a standard color separation scanner, other images brought from archival storage, others created by the system software without previous originals, and text from the scanner or from the Scitex TEXTA Typesetter.

At the console for color work and page assembly, the operator can freely correct, adapt, and assemble images. The video display functions as a responsive, up-to-the-minute soft proof, as shown in the following pages.

Perfected images can be routed from disc memory to a versatile Scitex laser unit for exposure on halftone film, continuous-tone film, or special high-speed plates. With the Scitex LOGO Controller, the same data can pass directly to the heads of a standard electronic gravure engraver, making bromides unnecessary. Images can be transmitted by the latest techniques of digital communications, and on magnetic tape they can be stored for years.

Fashioning a page



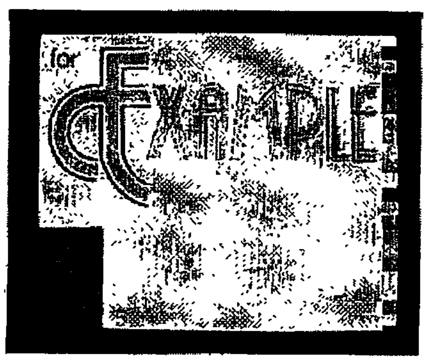


This is a look over the shoulder of an operator at a Scitex Response-300 console for color work and page assembly. The console gives head-up guidance including the degree of enlargement (zoom factor) and a menu for simple selection from among groups of functions.

One group of functions, electronic masking, isolates picture areas for either or both of two purposes: changing their color gradation and lifting them out of the picture. Masks can be created by computer-aided line drawing, by geometrical functions, or by automatic color analysis (distinguishing, for example, the tan of skin from the tan of sand).

The various gradation functions can work on one or more separations at a time. With masking, a picture can be divided into several areas, each for different gradation treatment. Graphs can be displayed to show how the specifications for tone reproduction are changing instant by instant while the operator uses his visual judgment in manipulating colors to meet the job's demands. With the computer saving a fallback copy of the picture in case the operator errs or has second thoughts, he can freely manipulate highlights and shadows, gamma, color balance, and other factors, approving or retracting each change with the press of a button.

For text and line art, the last word in versatility

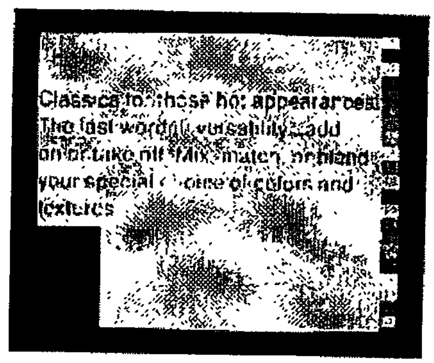


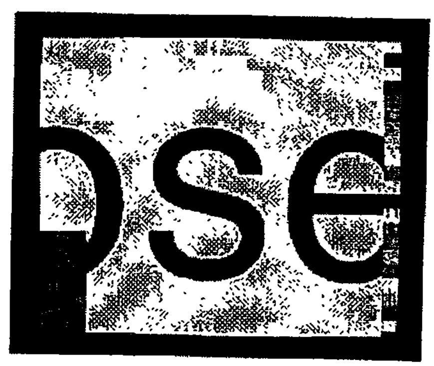
All kinds of line art and typeset text can be input in monochrome scans and reworked on screen to exact specifications. Line art is colored literally by the numbers. From the millions of colors the system makes available, the operator can choose up to 256 different tints, by on-screen color mixing or by numerical specifications. Any area can be tinted in any color.

Line art has its own menu of functions, since its demands differ from those of continuous-tone images. Text, in particular, benefits from very high resolution. Response systems can transcribe line art at up to 1000 lines per centimeter (2500 lines per inch), while not wasting system resources on raising the resolution of pictures elsewhere on the page.

Some functions are available for all graphics, for example cropping, sizing, and repositioning. Line art can also use mirroring and step-and-repeat functions.

Lines, patterns, and geometric shapes can be added to the image by drawing or by automatic software. Frames are a specialty, and the automatic framing functions extend even to producing high-quality outline type when solid type was scanned.

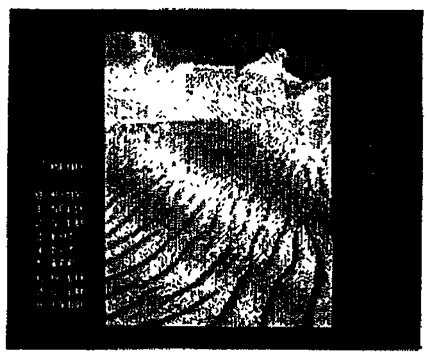




Two Scitex inventions, available for Response systems, are specializers in line art. The TEXTA Typesetter takes computerized text, graphic symbols, and composition codes directly from modern composers and introduces them to the Response system without scanning. The text assumes any size and weight with digital perfection, in any of a thousand popular commercial type styles or in custom typefaces developed at the Response system itself. The lines of text, once in the system, can be manipulated like any other line art. Magnification can demonstrate the text image's quality.

Another Response line art device is the LYNART Console, a black-and-white graphic assistant to the main console station. In departments with more work than the system's color consoles can handle, the LYNART provides inexpensive help with line art processing, leaving more time for full-color work and final page make-up at the main picture-editing station.

Assembling images, not films



At every stage of processing, the precision of the color monitor has dramatically reduced the number of proofs required. The monitor can be calibrated to match the color characteristics of any ink/stock/press combination, and each calibration can be remembered by the computer and called back whenever appropriate. Even in the middle of a job, the effect of each color-correction formula can be examined.

The last stage of work on the console is image assembly, also a filmless procedure. The operator superimposes images to precise numeric specifications of location and angle, or uses his stylus as a pointer and makes placements visually. Line art such as text is merged in at such precision that sharp line edges may cut through dots of process photography. Effects such as ghosting and knockout type, last-minute adjustments in scaling or even color, and specifications for overlap/underlap (shrinks and spreads) and for undercolor removal are all carried out with the same computer precision as the page is built up on screen.

When the page has its final form, plates or film separations may well be exposed for the customer's proof . . . the first materials consumed, in many instances, since the originals were mounted for scanning.

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The separation is a signal

For top quality in any process-color medium, final separations are sent from the computer in the form of control impulses for the chosen output hardware. Imposition, including automatic registration marks, trim marks, and printer guides, automatically follows operator specifications. Registration is never a problem because the data cannot drift.

For film exposures up to 86.5 by 122 centimeters (34 by 48 inches), incorporating one to four separations or several pages at a time, Scitex laser exposure units combine quality with high throughput, working at millions of laser impulses per second.

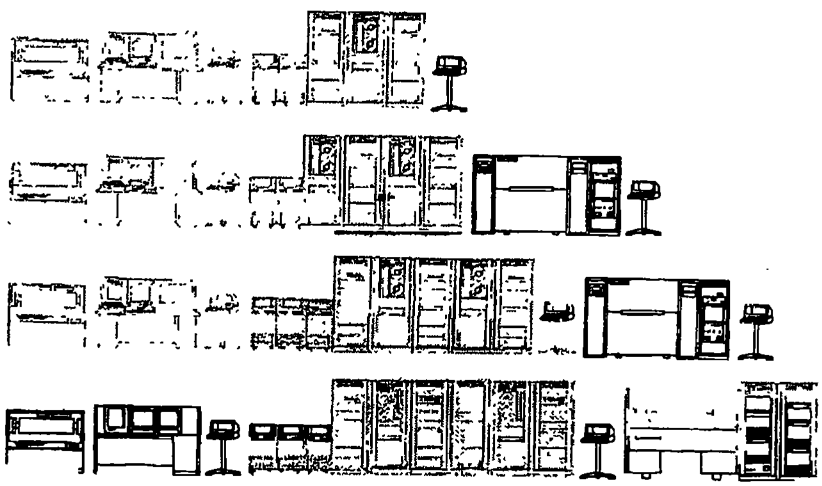
The laser gives electronic screening at any mesh and angle, at the operator's discretion, in square, round, elliptical, or pincushion dot-shapes. The same units can expose continuous-tone films and even certain plates from the same image data with no time lost in changeover.

For filmless gravure production, the data can run directly into the head or heads of an electro-mechanical gravure engraver from Scitex's LOGO Controller.

Magnetic tape is convenient not only in archiving but also in shipping images for proofing or production remote from the pre-press department. Alternatively, Response images can travel by commercial telecommunications.

Response output for Kazuo Yamamoto's Mountains and Rivers, courtesy of Toppan and of Yama-Kei Publishers.

From the ground floor, the smooth way up



The smallest Response configuration, with the separation scanner doubling as the system's exposure unit, provides fully electronic pre-press at minimum cost and commitment. As a department grows in experience, it can expand its scope with additions and upgrades to the Response system that keep pace without disrupting or diminishing the profitable use of current equipment.

Scitex's system design rests on the principle of cross-compatibility with scanners, composition systems, and other pre-press equipment from America, Europe, and Japan; and on the principle of upward compatibility for smooth modular growth from any initial configuration. Large configurations, whether purchased as new turnkey systems or gradually evolved on site, can provide for increased productivity, along with several forms of output, specialized consoles, scanners of various kinds, and supervisory stations with software for job coordination. Each system's various work-stations operate simultaneously and independently, but with their alternate control links and high-speed data paths they form an integrated, flexible ensemble.

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Response 300: On-line retouching

Clive Goodacre

Described as a 'front-end colour system' Response 300 opens a whole new chapter of computer creativity allowing the operator to montage pictures in almost unlimited ways, replacing days of laborious manual work. The ability to 'spray' colours onto the colour video image is yet another facet of this ingenious system.

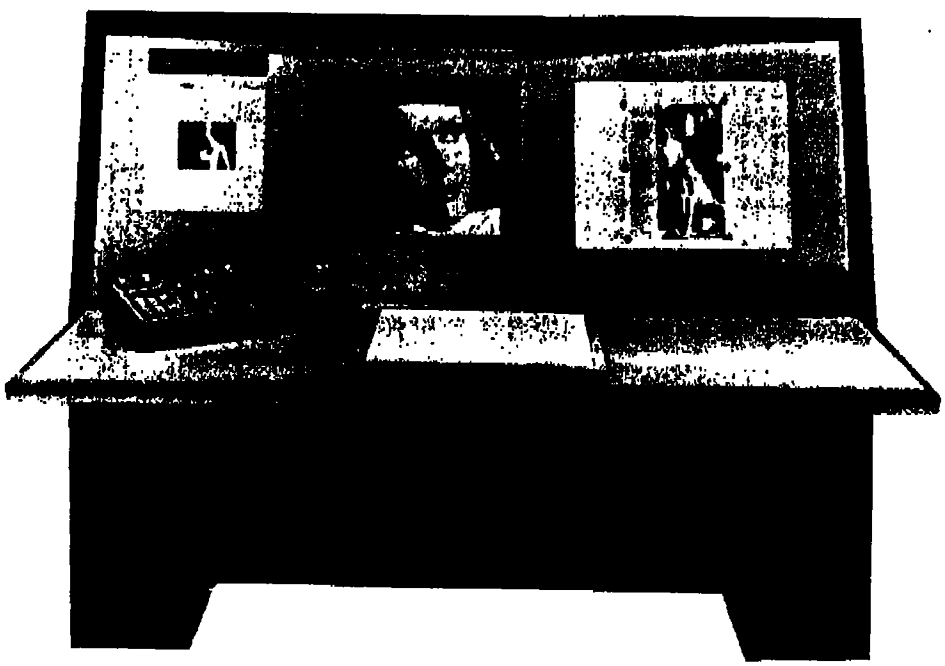
Since its introduction at GEC Milan in May 1979 it has been generally agreed throughout the industry that Response 300, built by the Israeli company Sci-Tex, is something of a technological *tour de force*.

So far there has been nothing like it and as the first of its type can be best described as a front-end colour system. Response 300 is not a prototype and the system on show in Milan is now installed at a customer in Hamburg, Germany. The first production batch of five models, costing a minimum of $800 000 each, has all been sold mainly to Japanese and US concerns while 98 other systems have been supplied primarily for cartographic and textile applications.

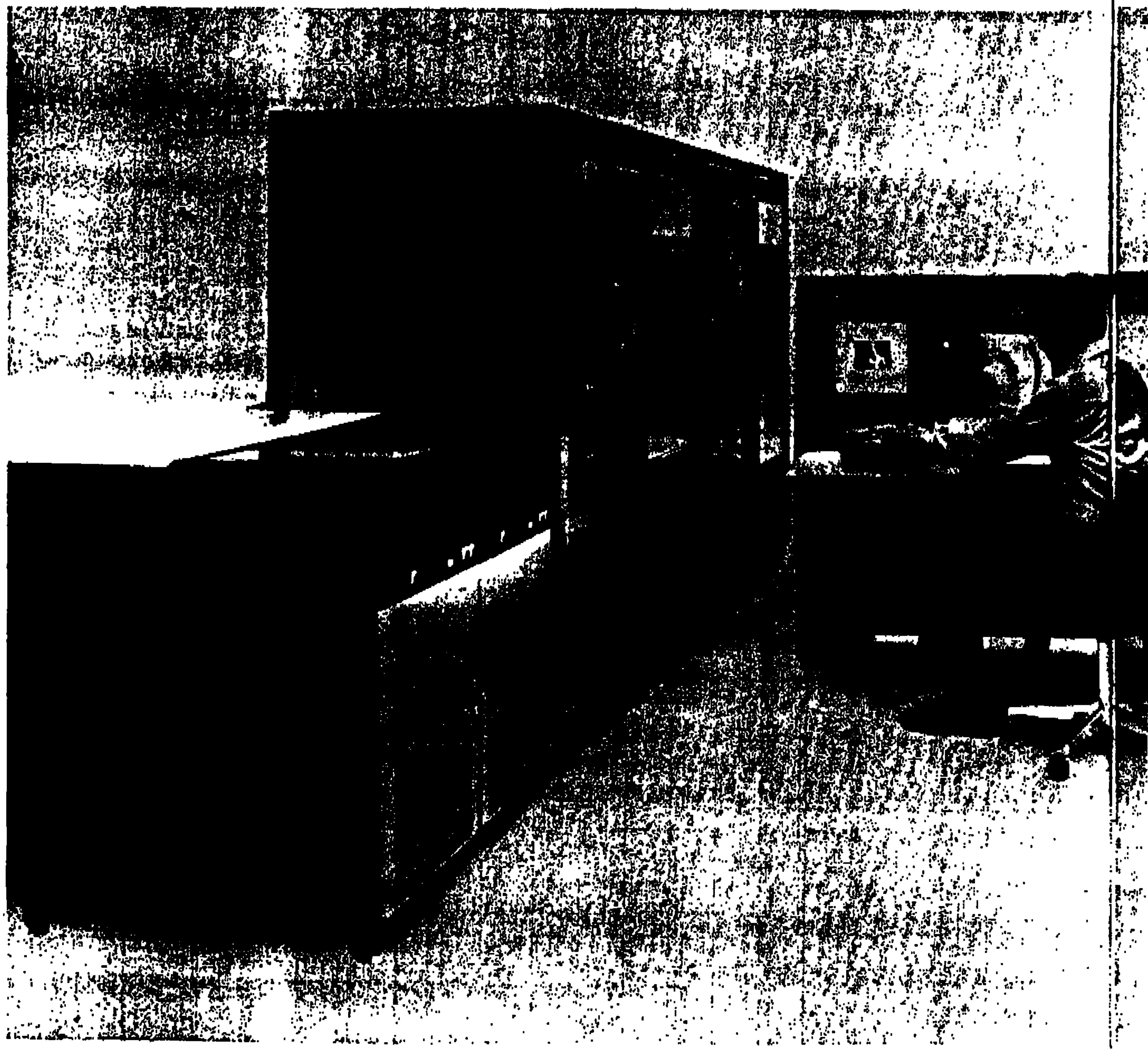
The system does not include a colour scanner, but will interface with most recent models, although some older analogue types can be used with a digitiser. The Response 300 system itself comprises two disc stores; a colour image processing console equipped with a colour VDU, back-lit transparency viewing panel and 4 800°K illuminated light box; master control terminal; a laser film recorder; two digital computers and two magnetic tape units.

Transparencies to be processed are scanned into the system as can be any linework, type or monochrome pictures. Because transparencies do not have to be enlarged to their final size and the use of the output drum is eliminated, the scanner becomes a highly productive machine.

4 Pages



The Response 300 image processing console: comprising colour VDU, transparency and reflection copy viewing areas and controls.



Additionally it can be used for conventional separations once the Response 300 information has been fed in.

The digital signals from the scanner are stored in a large capacity magnetic disc store, each item identifiable by a job number, and capable of holding several pages on a single disc pack. For longer-term storage this information can be transferred to magnetic tape. Essentially two categories of processing operations can now be carried out, one largely the equivalent of conventional retouching or dot etching and the other of make-up and assembly, but both operations can be intermixed at will.

Each colour separation can be brought onto the display screen in turn for examination and the characteristic tonal curve can be superimposed to show the effects of any adjustments which are made. When the operator is composing the final page format he is able to see in colour within a very short space of time the effect his commands have

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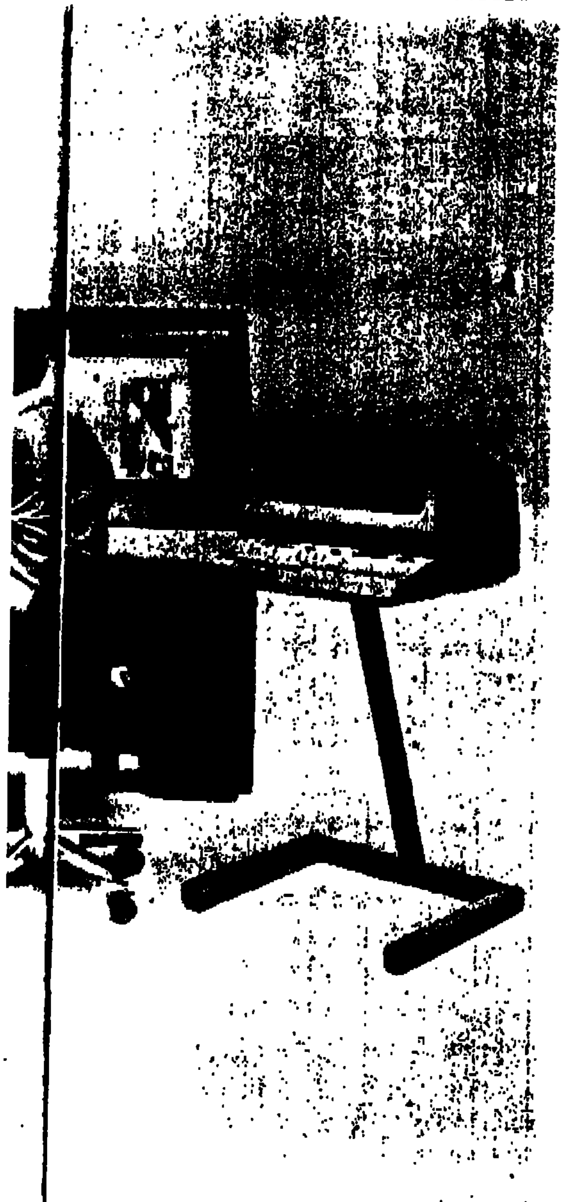
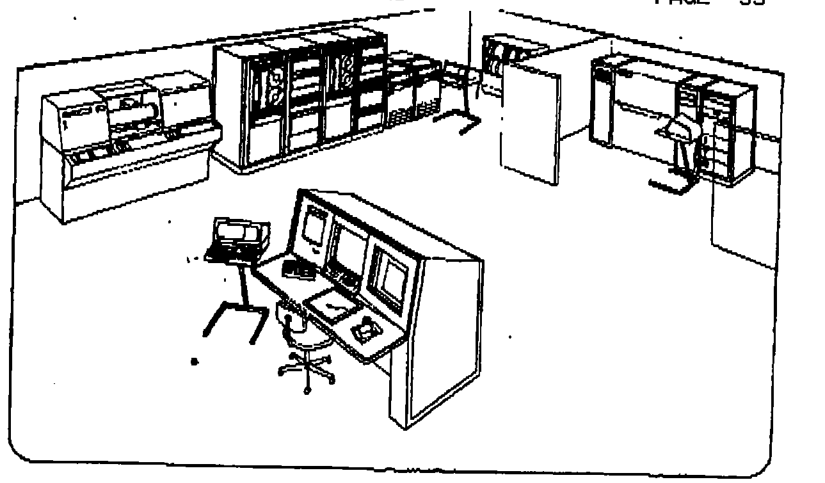




made on the master control terminal. Throughout processing the computer maintains a continuous dialogue with the operator on its VDU checking that all instructions are complete and correctly entered. When tints are being specified the operator can see both a percentage readout of each process colour alongside a swatch of the actual colour – plus of course the tints in position on the work-in-progress displayed on the screen.

A truly bewildering range of modifications can be made on Response 300 which by conventional means would take a week or more and in some cases not be possible. For example a multi-image repeat overlap of the same image decreasing in size against a vignetted background during one demonstration took about 15 minutes while conventionally it would have required at least ten separate scans plus airbrushed artwork plus somewhere between 40–60 pieces of film.

Cut-outs are handled by the operator first taking the light pen

Spread: Response 300 system.

Top: Schematic layout showing complete installation with colour scanner and laser film recorder.

Above: Operator at work using electric 'airbrush' retouching facility.

around the outline, this roughly defines the limits where the computer is to search for the join between the subject and other elements of the picture. A zoom magnification control allows the operator to see how exact the work is. Should an element within a picture require enhancement this cut-out facility allows a very fine white outline to be added.

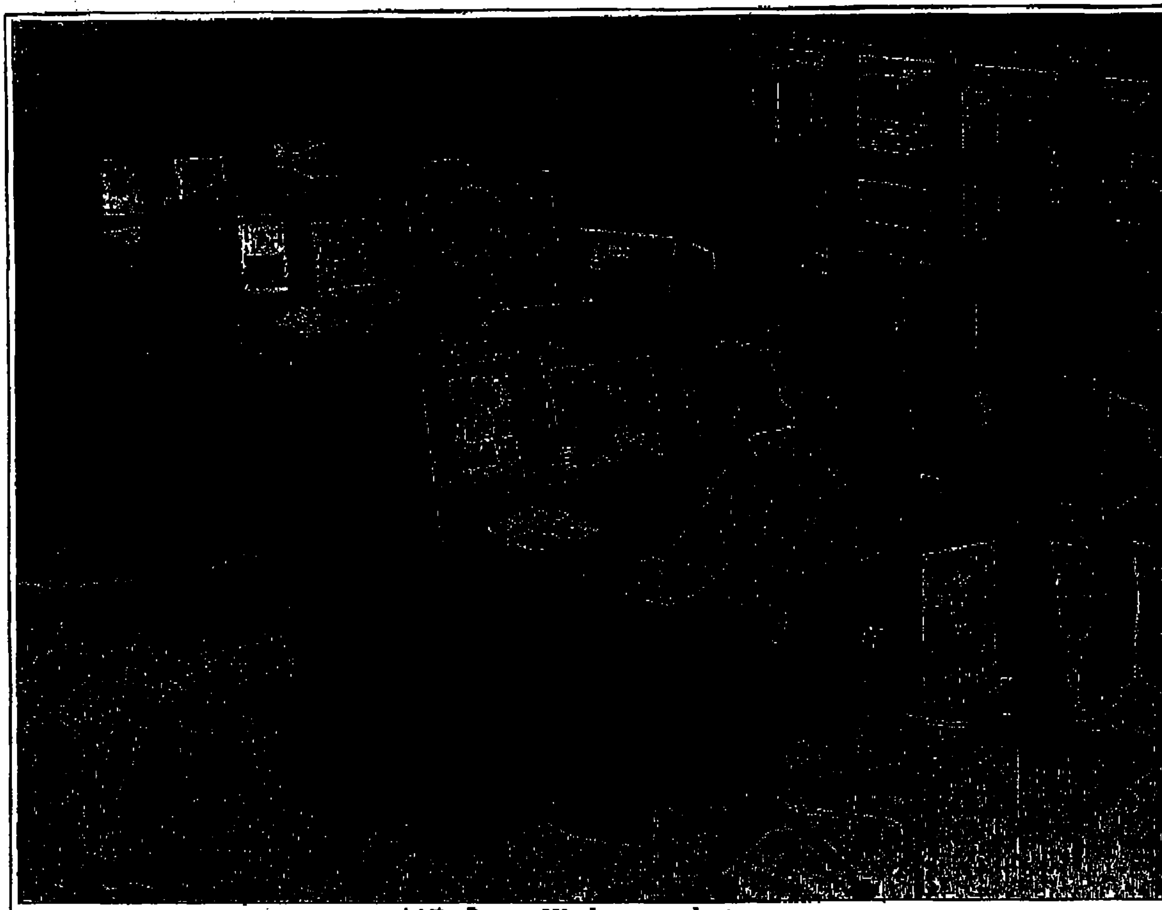
The light pen, which is moved over a flat digitising area underneath the colour display, performs a number of interesting functions in addition to simpler area defining operations. Used in one mode it becomes a densitometer with dot percentage or contone density displayed on the readout portion of the make-up screen. Creatively the most impressive facility is the light pen's use as an electronic 'airbrush'. Slide controls on the console allow the operator to adjust the colour which is then 'sprayed' onto the digitising table with the corresponding effect appearing on the screen exactly as if a real airbrush were being used. Tilting the pen alters the width of 'spray' and the dwell time is proportional to the colour added. On one demonstration the operator added an even sun-tan to a girl's face, put in a beauty spot and finally 'sprayed' in eye shadow for a truly remarkable and lifelike effect.

Response 300 also has a wide variety of overall processing programs allowing page imposition instructions, register marks, printing process characteristics, anamorphic scaling for flexo, and many others to be carried out.

Once processing is complete and the final 'soft-proof' on the colour display is approved each process colour is exposed in turn on the drum of the laser film recorder which writes individual dots corresponding to conventional screening. If during processing a printed proof is required a set of films can be produced with the images arranged either imposed or scattered when only portions of pages are needed. For gravure it is also possible to produce films for making offset press proofs that will emulate the colours obtained by gravure printing.

Options include modified versions of the laser film recorder to produce contone films or directly expose offset plates and the ability to accept digital composed text on tape or floppy disc to be electronically typeset by the system.

For the print buyer developments like Response 300 introduces a whole new range of graphic opportunities and for the printer, by directly linking the computer with the graphic arts, there is now a system truly able to recreate the original.



Sci-Tex Response 300 colour page make-up system

THE MAGIC PAINTBOX

Latest electronic developments are bringing about dramatic changes in the world of colour origination

THIS year, all the signs seem to say, marks the beginning of the latest revolution in printing technology. Colour page make-up – intricate, time consuming, difficult and costly – has been given the electronic data processing treatment, worked over with a touch of computer magic and transformed into a simple, speedy, reliable, and flexible process that eliminates intermediate materials, uses minimal manpower, and gives the user virtually unlimited control over the process to improve, enhance and optimise the use of colour images and text.

Today it is possible to take a handful of transparencies and some text and from them, without needing outstanding skill, deliver within the hour a set of separations on film for the production of litho plates for a fully assembled, colour corrected, retouched page. With a bit of extra electronics you could also have the wherewithal in digital form to run a laser platemaker directly, an automatic gravure cylinder engraver or a laser gravure engraver instead. Or as well.

The machines that perform these colour miracles are far from cheap, but they are certainly powerful. And perhaps the most significant thing about them is that they are not in the prototype stage. So good are we now at coping with digital data processing change that the systems have come from a twinkle in the designer's eye only a little more than a year ago to fully developed systems, all able to claim substantial users.

GEC in Milan in 1979 saw the first major public showing of colour page make-up systems from Crosfield, Hell and Sci-Tex. Ipex 80 at Birmingham saw established systems from these three major contenders in the field that drew full houses for every performance of the live demonstrations. Five hundred people a day during Ipex 80 queued and pestered organisers for tickets to see each of these maker's shows.

There can be no doubt that just as computer-assisted composition has become the norm in the industry, computer-assisted colour origination will inevitably gather momentum until it becomes the accepted method. Possibly more quickly than we might expect, for as in other walks of life the print industry has become more used to accepting change brought about by the computer. There is not the same suspicion around.

But again, as with electronic composition, blind acceptance isn't the best way to get on with colour technology. The revolution may be inevitable; but it is as well to know, at least in outline, how the systems work and what they can do.

All the systems we are talking about, that is by Crosfield, Hell and Sci-Tex, are developments of the techniques used in electronic colour scanning. Briefly, the scanning systems work like this: colour originals – transparencies or reflection copy – are scanned by a reading head which rather like a colour tv camera separates the picture into separate signals for the three primaries and black. These signals, in digital form, are then used to drive a light or laser source to expose the four films of the colour separation. While the signals are in digital form they can be subjected to some manipulation, the most obvious of course being re-sizing or scaling.

In between scanning and film exposure the digital signals can also be held on magnetic disc in digital form and subjected to almost any kind of manipulation, and before long some manufacturers had developed a tv screen 'window' so that the operator could view the colour picture on magnetic disc and alter anything about it he chose: size and colour values mainly, and with limited retouching and masking.

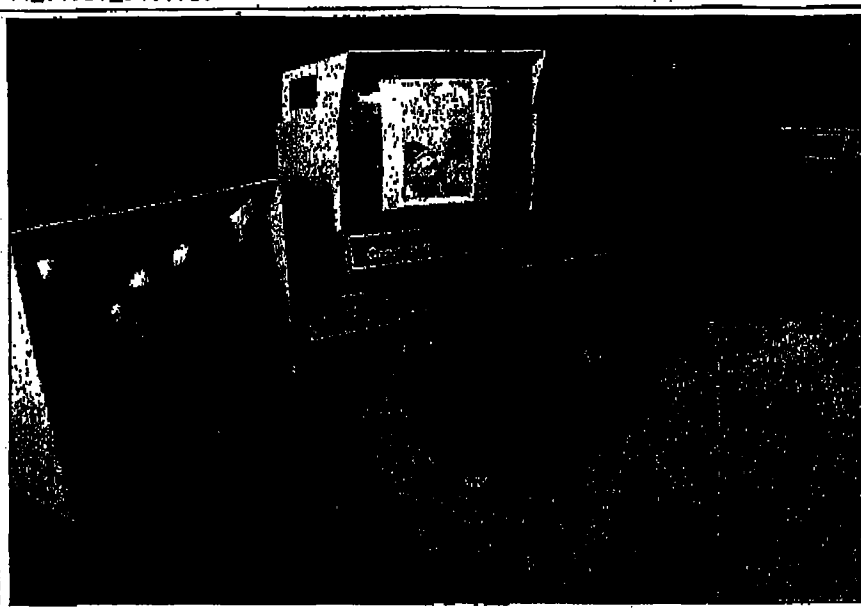
A bit more electronic data processing power and the systems were developed to the point

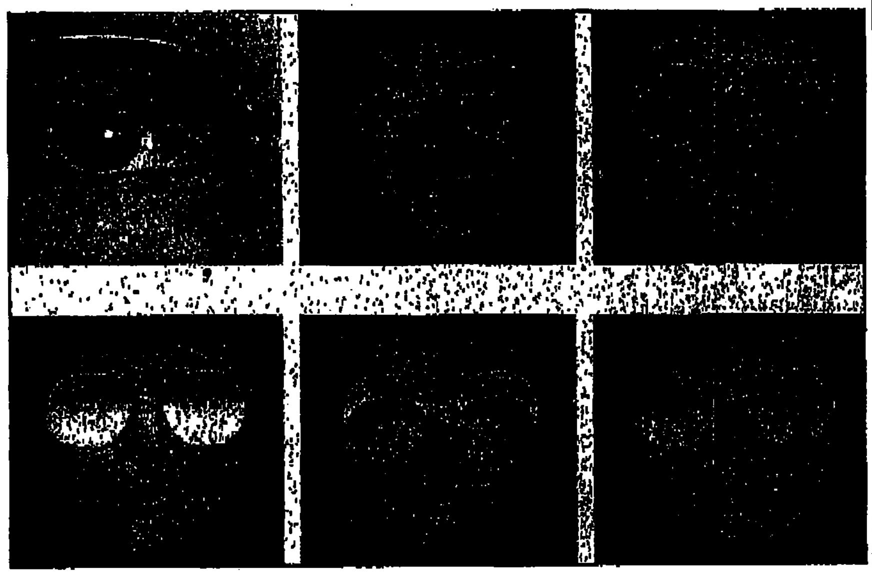
where the originals can be read in separated form on to disc and from there called up by the operator on his video screen where, with the aid of a cursor and a 'menu' of computer instructions, they can be sized, placed in position on the 'page', cut out, skewed, altered in colour value, masked and retouched, in some instances right down to having control over the single picture element stored on the disc (about a quarter of a dot).

Once the page make-up is completed it is viewed on the video screen as a whole and fed to the output where it can be used for a number of functions. The most usual is to drive the light or laser source to expose the separations for the page layout on film. Alternatively it can drive a laser platemaker in some versions, or it can drive a computer controlled gravure cylinder engraver (the Helio Klischograph) or engrave a plastic gravure cylinder by laser (the Crosfield Lasergravure). In some versions on offer the digital data for the whole page can also be stored on magnetic form for future use, or even for future amendment and re-use.

This brief description skirts a lot of the technicalities and it is of course an amalgam of the qualities held in common by outfits from Crosfield, Hell and Sci-Tex. The philosophies of the different models vary, with differing emphasis on operating characteristics – speed, positioning, masking, retouching, on-line and off-line operation, communication with other units and so on.

The variations – it's obvious really – seem to stem from where the designers started, ie what kind of scanner they had to begin with.





Top: Crosfield Magnascan 570 colour page make-up work station and video unit
Above: Changing model's glasses to tinted and graduated lenses it all done electronically on video screen with the Hell Chromacom

Crosfield 570

Crosfield is Britain's major company involved in electronics for print and one of the world's leading suppliers of electronic colour scanners.

Their electronic page make-up system is the Magnascan 570, introduced towards the end of 1978 (after a trial run at Drupa 77) and by now considerably enhanced.

The scanner from which the 570 was derived, and around which it has evolved, is the Magnascan 550, a powerful digital scanner which can separate all four colours and expose simultaneously an A4 size job in less than six minutes.

In its latest form the Magnascan 570 offers a wider range of options to the user. Sizing, positioning, and control of colour values, with the ability to generate a range of shaped masks and borders, have from the start been features of the 570, along with the facility to execute accurate cut-outs with the cursor which the computer could 'smooth' automatically.

Latest enhancements to the system include two major developments – the addition of an additional disc drive and the development of a considerable retouching facility.

With the extra disc drive the Magnascan 570 can operate on or off line so that the scanner itself is not tied up, and there is now no need to go to the film exposure stage with the Crosfield gear until the job is completed and everybody is satisfied with it. The saving is in costly materials as well as in time.

The off-line facility means that more than one job can be in progress at the same time, and with communications ability the system can interface with other systems. The colour retouching station for the Magnascan 570 gives the operator the power not only to repair deficiencies in original artwork but to enhance it or alter it to suit client requirements.

Just for example (and it is a trick favoured by all the demonstrators of computer retouching) the 570 operator can change the eyeshadow and lipstick on the photographic model to match her dress or anything else in the picture, or in another picture on the page. Just like that!

Output from the Magnascan 570 is usually to the Magnascan 550 exposure section and there are several installations in the UK already using this method. But output can also be fed to their Lasergravure 700 system, developed to engrave plastic gravure cylinders.

Hell Chromacom

From beginnings in facsimile picture transmission the Hell company, based at Kiel in Germany, is involved in the application of digital techniques in two major areas of print technology with Chromagraph colour scan-

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ners and Digiset electronic composition systems. They also have the Helio-Klischograph which has brought computer power to gravure cylinder production (and potentially gravure cylinder storage by holding the job on magnetic media instead of on costly, bulky and heavy cylinders – but that's another story).

The Hell scanners are widely used and deservedly popular and they were the first to use laser light to expose the colour separation sets, to give an extremely sharp dot.

With their wide experience in digital image handling the company developed, for use with the Chromagraph scanners, the Combiskop control unit, which lets the operator manipulate the colour image he is working with before it is scanned, by viewing it on a colour video unit so that he can set up the colour values to his liking or to client requirements. When the unit was launched there was talk of its being used to show clients the final job as a sort of video proof, although there are no reports of its being used in this way in the UK yet.

From experience with these two systems Hell showed for the first time at GEC in Milan their highly developed Chromacom colour page make-up system.

The Chromacom comprises the Chromagraph DC 300, the Combiskop 308 and a merging station.

As with other colour page make-up systems the operator 'enters' the images – which can include text elements – and positions them with a simple cursor on a make-up table. He is then able to move an electronic cursor around the 'page' on display on the video screen and perform a wide range of operations. He can position and reposition the elements, generate coloured areas and picture frames, insert continuous colour schemes as picture backgrounds, retrieve type and symbols from the data inventory, rotate pictures, change their scale, produce overlays and insert duplicate images.

On retouching the system offers control, simply, over every digital picture element, that is to say the operator can change the colour value of an area equivalent to a quarter of a dot, and on larger areas can use an electronic version of brush retouching or even an electronic spray can.

All of this make-up work is done before film is exposed, making the system economical in materials (after you've paid for it, of course – upwards of DM400,000 is the area).

The Chromacom most usually drives the output end of the DC 300 but it could drive the Helio-Klischograph.

Sci-Tex Response 300

Unlike the other two the Sci-Tex Response 300 system derives more from computer involvement than from scanner experience.

The Israeli firm was founded in 1968 and it has an established reputation as a technological innovator.

Their Response 300 colour page make-up system was first shown at GEC in Milan in 1979 where it caused a considerable stir thanks to its power.

The system on show at Birmingham this year is even further developed.

Having been developed around a powerful computer rather than around an existing scanner the Sci-Tex system lends itself particularly to extensive network use. Various elements can be linked together to provide multiple page make-up stations working independently or interactively and output can be fed to a number of devices – someone else's scanner (so long as it is digital), metal or plastic gravure engraving systems, or Sci-Tex's own laser plotter to produce film. They also produce plates directly by laser.

Although the heart of the Response system is the computer, the apparent centre of operations is the human interface similar in concept to the others in the field – a colour console with colour video display, make-up table with digitizing and control stylus, and a push-button control panel to input the most commonly used commands.

The list of complex or tedious colour jobs that the Response 300 can do automatically and instantly is lengthy: display image in whole or in part, magnify any portion for close work, retouching and dot etching, display and manipulation of tonal gradation, electronic airbrushing in any colour, degrade and double exposure, dynamic undercolour removal, automatic generation of geometric forms, insertion of standard elements (logos, for instance) from memory, shrinks and spreads, selective overlapping, reverses, tints, cropping, rotating, and juxtaposing, and sizing in true and distorted proportions.

Thanks to the data processing power behind it, one of the most impressive functions of the Response 300 (to watch in action at least) is the automatic masking facility. The operator has only to indicate even a complex cut-out with moderate precision and the system automatically measures the colour values of the main subject against the background and generates the electronic mask automatically and instantly.

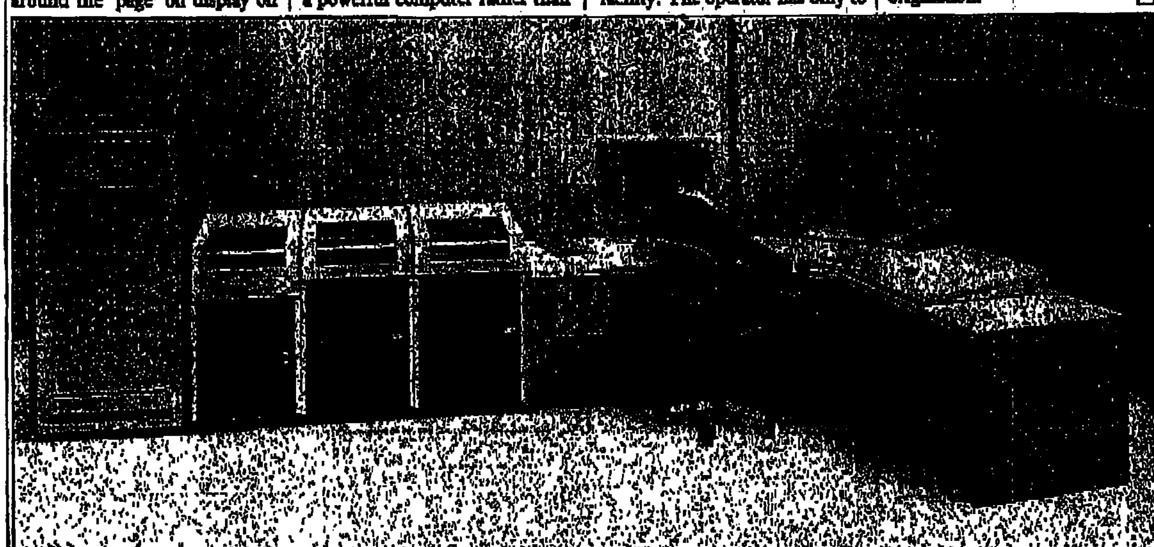
All of these facilities make the Sci-Tex Response 300 an extremely powerful page make-up tool. It is unlikely, mind you, that many printers could have the throughput, or be able to afford such a system, but for the large trade house or the very large printer it presents amazing flexibility. Twenty-five have so far been installed worldwide (that is between unveiling at GEC Milan in 1979 and going on show at Ipex in Birmingham in 1980). Another 35 orders are said to be in the pipe-line.

You want one?

Plainly colour page make-up systems are not for the poor. Equally plainly, though, where there is the work to do they are worth the money. Estimates vary on their productivity but it is claimed that such a system can do a job in an hour that would take a highly skilled man a day. Some say two days.

So the saving in manpower is enormous and in itself would guarantee that their use will grow. Savings in film and material can also be set against the high purchase price.

But it is the speed of service to the client and the ability to offer him visual results from his originals beyond anything he has hitherto been able to expect that will guarantee the rapid acceptance of the new colour page make-up systems by the printer who is in the business of colour origination. □



Hell Chromacom system has powerful disc back-up and wide facilities on video screen

A Prototype Spatial Data Management System

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ABSTRACT

Spatial Data Management is a technique for organizing and retrieving information by positioning it in a spatial framework. Data is accessed in a Spatial Data Management System (SDMS) via pictorial representations which are arranged in space and viewed through a computer graphics system. These pictures can be created by an interactive graphical editor, allowing an SDMS to serve as a personal repository of diagrams, text, and photographs. Pictograms can also be generated from data in a symbolic database management system, allowing SDMS to be used as an interface to large, shared databases.

A prototype SDMS has been constructed which employs a set of color, raster scan displays driven by a large minicomputer. The user can create and examine data surfaces which are larger than the display screen, traversing a surface and zooming in and out to control the level of detail displayed. The prototype system provides a uniform mechanism for accessing a wide variety of data types in a manner which does not require the use of a formal command or query language.

Key Words and Phrases: Computer Graphics, man-machine interaction, database query languages, graphics languages.

CR Categories: 3.7, 8.2

1. INTRODUCTION

Spatial Data Management is intended to allow a person without formal training to access information in a computer. Previous approaches to this problem have involved replacing the usual formal database query language with some more friendly means of specifying the data to be retrieved. These approaches include letting the user express his query in natural language [1] [2], giving examples of the desired results [3], or describing the retrieval process graphically [4]. However, each of these techniques still requires that the user precisely specify the data to be retrieved. Composing such a specification requires a knowledge of the contents of the database and frequently requires some familiarity with its structure as well.

A Spatial Data Management System (SDMS) addresses this problem by organizing information in a much different manner. Whereas a conventional database management system organizes information in a number of abstract name spaces which are referenced by providing values to be matched, an SDMS organizes information in concrete two-dimensional geometric spaces which are more familiar to computer-naive users. The data is given a pictorial representation and placed on a surface which is viewed through a computer display. One such surface, representing a database of ships, is illustrated below. By tying the appearance and location of each picture to the semantic content of the data which it represents, the system enables the user to access information through the simple process of directing attention to the appropriate portion of the data surface.

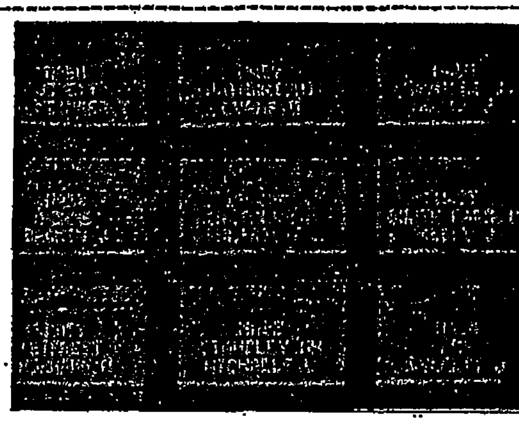

Figure 1. Ship Database

The construction of a useful Spatial Data Management System requires the solution of two key tech-

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nical problems:

1. Providing a means by which a user can conveniently view a large data surface, and

2. implementing a mechanism for creating meaningful pictorial representations of symbolic information.

Two previous approaches to the first problem are described in [5] and [6]. This paper describes a prototype SDMS which marries some of the concepts of spatial organization developed in that early work with current database technology to provide a system which can be used to solve real problems of database usage.

2. THE PROTOTYPE SYSTEM

The prototype SDMS provides a variety of mechanisms for creating, viewing, and modifying a Graphical Data Space (GDS) consisting of a set of connected surfaces upon which the data is displayed. This Graphical Data Space is not restricted to containing the formatted data found in conventional symbolic databases but can include anything that can be represented in a computer graphics system, such as charts, diagrams, maps, photographs, and text. In this way, SDMS may serve as a uniform interface to a wide range of dissimilar datatypes.

2.1 The Graphical Data Space

One seemingly straightforward way of organizing data spatially would be to arrange everything on one large surface which would be displayed in its entirety. For most applications, however, such a display would not only be prohibitively expensive, but it would require the user to be constantly moving about a rather large room in search of data. In order to allow the user to remain seated and to make the system more practical, SDMS uses a graphics display as a window through which selected portions of a data surface may be viewed at various scale factors. By allowing this window to move constantly over the data surface, and by providing suitable auxiliary motion and position cues, the sensation of interacting with a large surface can be preserved. The user can thus construct a mental spatial model of the data surface which aids in locating information. This process is aided by the use of distinctive colors and shapes, such that locations may be recognized by their appearance.

The Graphical Data Space may be partitioned into multiple data surfaces which are linked together in a network. The user moves from one data surface to another by means of special pictures called <u>ports</u>. Activating a port causes its associated data surface to become the current data surface. The motion from one data surface to another is similar to that of menu-based systems such as ZOG [7]. While this ability provides a convenient mechanism for partitioning one's data, motion through a network is a foreign concept to most users, and in practice navigation through any appreciably sized network has proven difficult [6]. The ZOG system has addressed this problem by allowing extremely fast transitions between frames. While the results are promising, the technique is only practical for frames which are simple enough to display quickly. In SDMS, the hierarchy of spaces is used most often for separating unrelated information or for providing alternate views of related information while the spatial arrangement within a data surface carries most of the load for organizing information.

Ports can also be used to activate programs external to SDMS. This facility provides a general purpose escape mechanism through which the user can employ various facilities of the operating system such as electronic mail, text editors, or any other subsystem. Such subsystems can be written specially for SDMS, such as the text display program illustrated below, which provides a secondary display of a document table of contents in addition to the document itself.

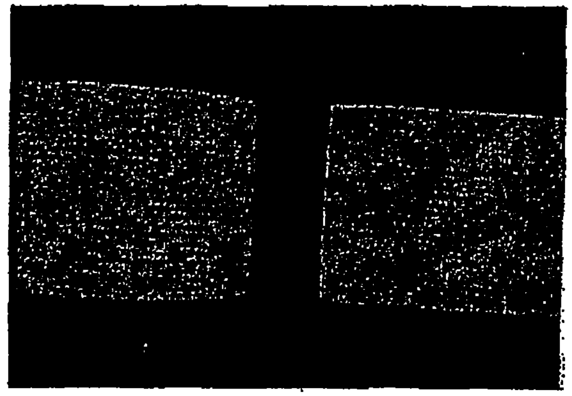

Figure 2. Text Display Program

2.2 The User Station

The user of SDMS sits at a display station like that shown below. The system provides three color, raster-scan displays, fitted with touch-sensitive digitizers. Additional user input can be performed through a three-axis joy stick, a data tablet, and a keyboard. The left-most of the three screens presents a "world-view" of the entire data surface. A magnified view of this data surface is simultaneously displayed on the main screen in the center. The location on the data surface of this magnified portion is indicated by a highlighted rectangle which appears on the world-view map. The two screens are shown below. The right-hand display is used for various other maps and for displaying a menu of commands for use with the graphical editor.

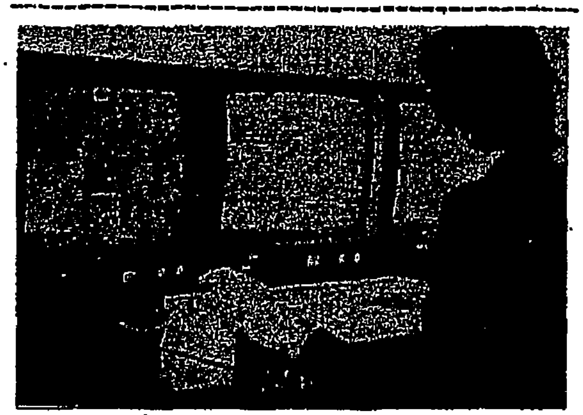

Figure 3. SDMS User Station

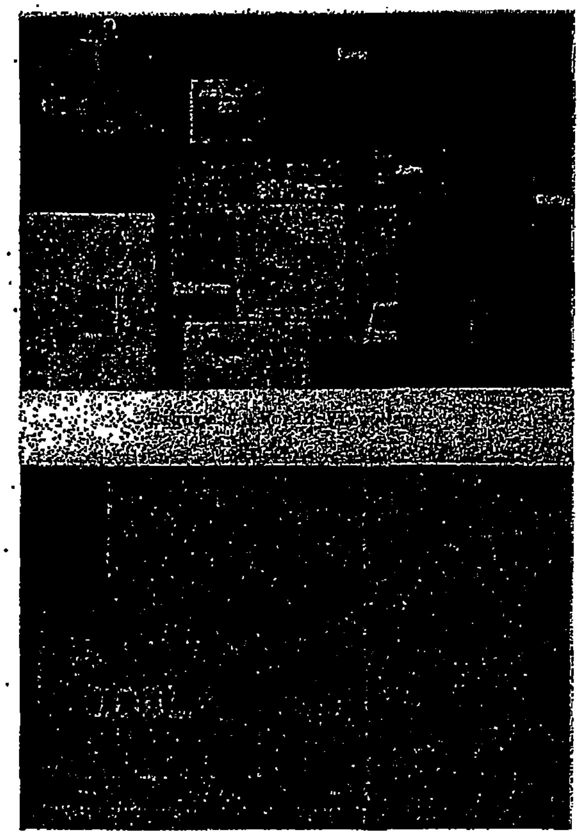

Figure 5. Main Display

2.3 Motion in the Graphical Data Space

The user can control which portion of the data surface appears on the center display by pressing on the joy stick shown in the user's left hand in the foreground of Figure 3. Pressing the joy stick in any given direction causes the user's magnified window to move immediately in that direction over the data surface. This motion is reflected in the corresponding motion of the highlighted rectangle on the world-view map, as shown below. The speed of motion is proportional to the pressure exerted on the joy stick. At the maximum speed the width of the center display is traversed in approximately two seconds.

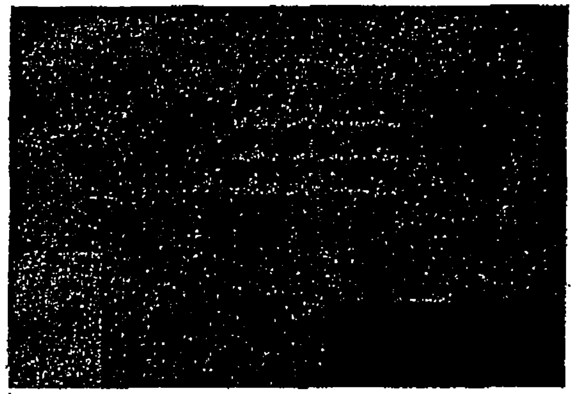

Figure 7. Main Display

A second type of motion which the user can perform is in a direction perpendicular to the data surface. Twisting the joy stick causes the picture to enlarge. This occurs in two stages. The first stage is done by zooming the display, a hardware technique which causes pixels to be replicated on the display, as shown below. The second stage depends on the user's position in the data surface.

Figure 8. Zooming the Display

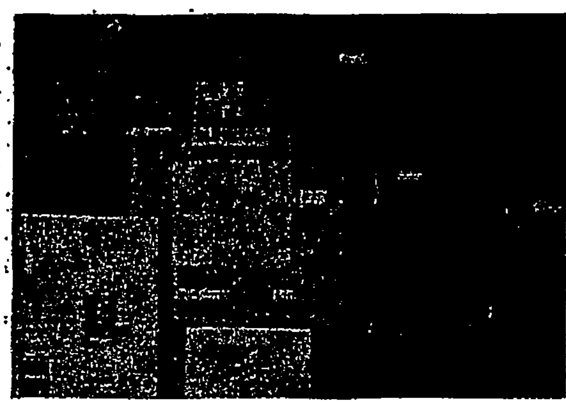

Figure 6. World-View Map

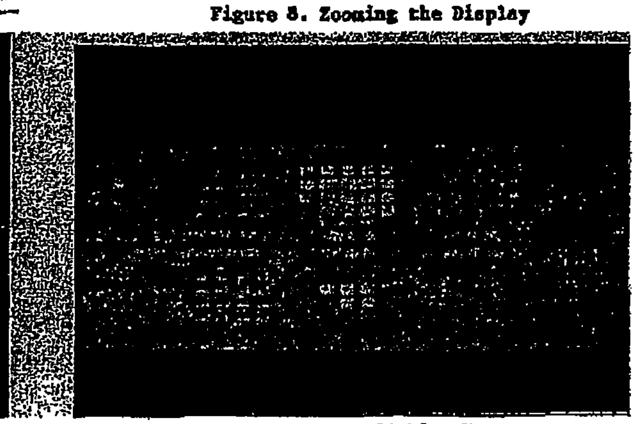

Figure 9. World-View Map

If he is positioned over a port, the port is activated, causing its associated data surface to become the current data surface. The result of zooming in on the "ships" port is shown below. Note that the world-view map has changed to be that of the new data surface.

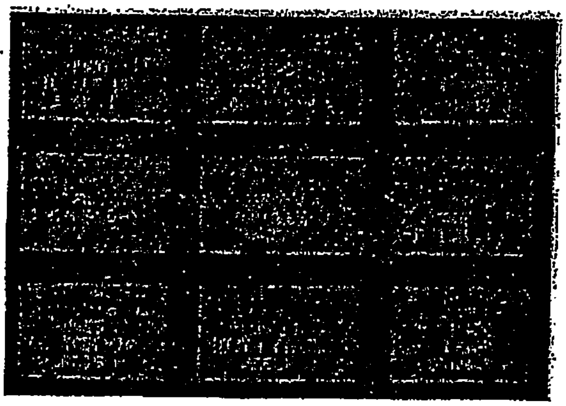

Figure 10. Main Display

Some data surfaces are stored at several levels of detail. Zooming in on such a data surface causes the more detailed version to appear. The following figures show the result of zooming in on such a data surface.

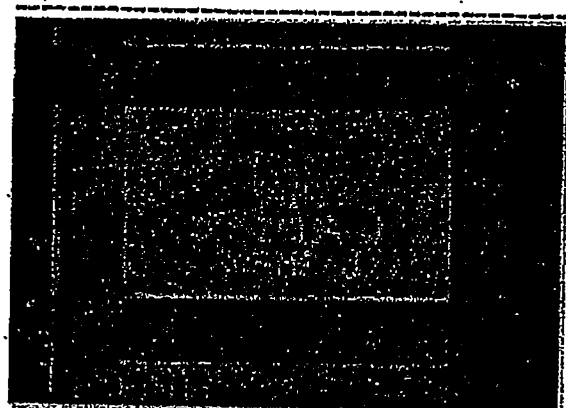

Figure 11. Zooming In

Figure 12. Detailed View of Data

2.4 Global Actions

There are four actions which the user can carry out regardless of his position in the graphical data space. These are:

1. selection of a navigational aid,
2. rapid transit,
3. using the interactive graphical editor, and
4. entering symbolic queries into the database management system.

The left-hand screen may be directed to display either of two forms of navigational aid. One of these is the world-view map, described above. The other is a map of the hierarchy of the data surfaces, illustrated below. Each data surface is represented by a labeled square, with the current data surface indicated by having its background color changed to yellow (the label is always visible). The lines connecting the squares show the possible routes (through ports) which can be taken from one data surface to another. The green squares indicate ports which connect to data surfaces already "owned" by another data surface. Thus, although ownership is hierarchical, the paths which can be taken through the various data surfaces form a network. The blue squares are "off-page-connectors" to other portions of the hierarchy map.

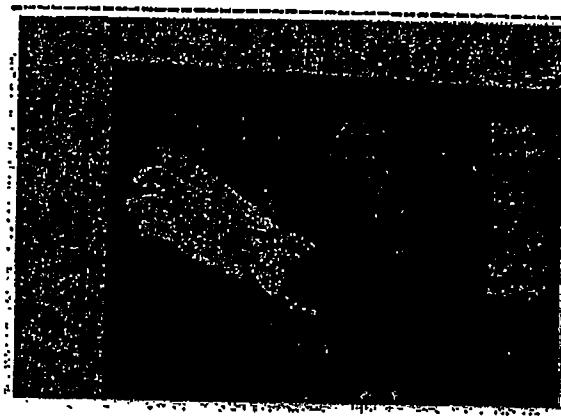

Figure 13. Hierarchy Map

Rapid transit is a mechanism by which a user may move from one point in the Graphical Data Space to another without traveling through the intervening space. Rapid transit is invoked when the user touches the navigational aid with his finger, as in the previous photograph. If a world-view map is displayed the user's window is moved to that location on the data surface. If the hierarchy map is displayed, the data surface which was pointed to becomes the current data surface. Rapid transit takes between one and three seconds. In order to provide immediate feedback to the user, the navigational aid is updated as soon as the screen is touched.

The graphical editor allows the user to annotate the data surface and add graphical data. It operates on the portion of the data surface currently displayed on the center screen. It is also used to edit the Graphical Data Space by creating data surfaces and ports. The editor is described in more detail in the next section.

Although a large portion of a user's need for access to information can be handled through the mechanisms described above, there are situations where the ability to precisely specify a query is required. In these cases, the user can employ a formal symbolic query language which is an extension of QUEL [8]. This language allows the user to define new data surfaces containing selected objects or to cause selected objects on an existing data surface to be blinked. The relationship between the symbolic and graphical modes of representation is discussed in more detail in the following section.

3. INPUT OPERATIONS

Graphical representations can be placed in the SDMS Graphical Data Space through either of two mechanisms:

1. Manual picture creation allows a user to create pictures with an interactive graphical editor.
2. Automatic picture creation generates a graphical view of a symbolic database under the control of a previously entered description.

The manual mode allows SDMS to function as a personal electronic workspace in which a user can store and retrieve maps, charts, diagrams, and photographs. The automatic mode allows SDMS to be used as an interface to a symbolic database which may be large, shared, and subject to frequent updates.

3.1 Manual Picture Creation

The SDMS prototype provides an interactive graphical editor which may be activated at any location in the graphical data space. Like many interactive painting programs [9] [10] it allows the user to select from a menu of commands which perform various graphical operations in response to coordinates input from a data tablet. The SDMS editor has the unique capability, however, of allowing operations which span an area larger than the display screen by allowing the user to move continuously over the data surface both within and between commands.

A person using the editor selects a function by touching with his finger a point on the menu which is displayed on the right-hand screen, shown in the following photograph. The functions include:

1. Geometric primitives such as lines, rectangles, circles, "ink" (continuous lines), and a random dot pattern which simulates an air brush,
2. graphical transformations such as translation and scaling,
3. attributes such as color and width,
4. a variable grid,
5. input digitized from a vidicon, and
6. a library of previously defined shapes.

The user performs these operations on the portion of the data surface currently displayed on the center screen. As he does this, the world-view map is continuously updated so that it always displays

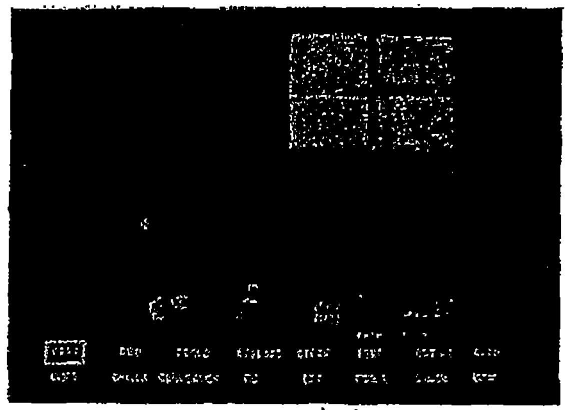

Figure 14. Graphical Editor Menu

a correct scaled-down version of the entire data surface.

An additional set of commands allows a user to create new data surfaces and ports and perform other operations described in the next section.

As with the joy stick and rapid transit operations, the user is given immediate feedback to every action. When a command is selected by touching the menu screen, a box is immediately drawn around the selected command, confirming its selection. If the command requires input of points on the data surface (as when drawing a line), a cursor appears on the center display. The position of the cursor is tied to the position of a puck on the data tablet on the table in front of the screen. Commands which require multiple points always provide some form of intermediate feedback. For example, the RECTANGLE command requires two points which define any two diagonally opposite corners of a rectangle. After the user has placed just one corner of the rectangle a white rectangle appears, with one corner fixed at the indicated position and one corner moving as the user moves the puck. When the user indicates the second point, the rectangle is drawn in the selected color.

The editor is described in more detail in [11].

3.2 Automatic Picture Creation

One of the most important uses of SDMS is as an interface to information stored in a conventional symbolic database management system. Such database may be large, shared with other users, and dynamic. While it would be possible to use the editor described above to manually create pictures for each entity in the database, this approach would hardly be practical for a database with hundreds, much less thousands, of entities. Furthermore, these pictures would have to be modified whenever the database was updated. Very often, such databases already exist in some symbolic database management system and, since they are shared with other users, can not be altered to fit into the SDMS framework.

To address these issues, SDMS provides a mechanism for defining a set of rules which determine how the data in a symbolic database should be expressed graphically. These rules form an icon class description and the pictures they create are referred to as icons. The icon class description used to create the pictures of the ship database shown on the preceding pages is shown below.